

ORIGINAL

The Cognitive Role of Lecturers in Sustainable Higher Education Development: A PLS-SEM Approach

El papel cognitivo de los docentes en el desarrollo sostenible de la educación superior: un enfoque PLS-SEM

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ABSTRACT

This study explores the factors shaping faculty awareness of sustainable development in higher education and analyzes the impact of faculty awareness on institutional sustainability. Data were collected from 339 lecturers in Vietnamese universities and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results show that Faculty training and competence (as discussed later), green campus initiatives, and national and international collaboration significantly enhance faculty awareness, while institutional commitment has a small but insignificant positive effect, teaching methods are not significant. Faculty awareness itself positively contributes to sustainable development in higher education, confirming its mediating role between institutional factors and sustainability outcomes. The study enriches the literature by highlighting the cognitive role of faculty in advancing sustainability. Practical implications include investing in faculty development, expanding collaboration networks, promoting green campus strategies, and translating institutional commitments into concrete actions. Limitations relate to convenience sampling and cross-sectional data, suggesting directions for broader, longitudinal, and mixed-method research.

Keywords: Sustainable Development; Higher Education; Faculty Awareness; PLS-SEM; Green Campus; Collaboration.

RESUMEN

Este estudio explora los factores que configuran la conciencia del profesorado sobre el desarrollo sostenible en la educación superior y analiza el impacto de dicha conciencia en la sostenibilidad institucional. Los datos se recopilieron de 339 docentes en universidades vietnamitas y se analizaron mediante el método de Modelado de Ecuaciones Estructurales con Mínimos Cuadrados Parciales (PLS-SEM). Los resultados muestran que la formación y competencia del profesorado (como se discute más adelante), las iniciativas de campus verde, y la colaboración nacional e internacional mejoran significativamente la conciencia del profesorado, mientras que el compromiso institucional tiene un efecto positivo pequeño pero no significativo, y los métodos de enseñanza no son significativos. La conciencia del profesorado, en sí misma, contribuye positivamente al desarrollo sostenible en la educación superior, confirmando su papel mediador entre los factores institucionales y los resultados de sostenibilidad. El estudio enriquece la literatura al destacar el papel cognitivo del profesorado en el avance hacia la sostenibilidad. Las implicaciones prácticas incluyen invertir en el desarrollo docente, ampliar las redes de colaboración, promover estrategias de campus verde y traducir los compromisos institucionales en acciones concretas. Las limitaciones se relacionan con el muestreo por conveniencia y los datos transversales, lo que sugiere orientaciones hacia investigaciones más amplias, longitudinales y de métodos mixtos.

Palabras clave: Desarrollo Sostenible; Educación Superior; Conciencia del Profesorado; PLS-SEM; Campus Verde; Colaboración.

INTRODUCTION

Sustainable development in higher education is increasingly recognized as essential for addressing the complex challenges of the 21st century. Universities are pivotal in fostering critical thinking, creativity, and social responsibility among students, aligning with the United Nations Sustainable Development Goals (SDGs). The integration of sustainable development principles into curricula is crucial for shaping future leaders who are aware of environmental, social, and economic interconnections. Effective integration of ESD requires a holistic approach, combining curriculum development with innovative teaching methods that promote active learning and critical thinking.⁽¹⁾ Universities serve as agents of change, equipping students with sustainability awareness and skills necessary for societal transformation and Faculty members design curricula that incorporate sustainability principles, ensuring that students grasp the interconnections between environmental, social, and economic issues.⁽²⁾ Faculty model social responsibility, promote student engagement in sustainability beyond the classroom, and pursue ongoing professional development to enhance their pedagogical practice.⁽³⁾ Educators' commitment to sustainable development positively influences curriculum design and pedagogical methods, leading to greater integration of sustainability topics into syllabi and promoting a culture of sustainability within institutions.^(4,5)

Faculty awareness directly correlates with students' engagement in sustainability initiatives, emphasizing the need for professional development in this area.⁽⁶⁾ Despite the recognized importance of ESD, many higher education institutions face challenges in implementing comprehensive sustainability initiatives due to fragmented approaches and inadequate resources.⁽³⁾ Faculty commitment and awareness are crucial for overcoming these barriers and ensuring the successful integration of sustainability into higher education. While the role of faculty in promoting ESD is critical, it is also essential to recognize the need for institutional support and collaboration among stakeholders to create a conducive environment for sustainable education.

Theoretical foundations

Institutional commitment (IC)

Institutional commitment is an important concept in fields such as education, organizational management, politics, and social governance. Institutional commitment refers to the attachment, loyalty, or formal promise of an individual or an organization to the values, objectives, rules, and activities of an organization or a social institution.^(7,8,9) Faculty institutional commitment can be defined as the degree of attachment, loyalty, and willingness of academic staff to contribute to the university or higher education institution where they are employed. This commitment is manifested through their belief in the institution's goals and values, their intention to maintain membership, and their active efforts to support the institution's overall development.⁽¹⁰⁾ In addition, institutional commitment is associated with trust, credibility, and flexibility in the implementation of policies or regulations.^(8,11)

In education, students' institutional commitment to their schools directly influences their intention to persist and their academic retention behaviors.^(7,12,13) At the societal level, institutional commitment helps maintain order, strengthen trust, and ensure the stable operation of organizations, while limiting opportunism and rule-violating behaviors.^(8,9,11) In governance, institutional commitment helps organizations achieve a balance between flexibility and reliability in the implementation of policy commitments.^(8,11)

For lecturers, clear institutional commitment and supportive policies—such as integrating sustainability into strategies, regulations, training, and research activities—enhance their awareness of the importance of sustainable development and encourage them to actively participate in related initiatives.^(14,15,16) At institutions with strong commitment, lecturers often perceive sustainability as an integral part of curricula, research, and extracurricular activities.^(14,15) However, when commitment is merely symbolic, lacking concrete guidelines or practical support (such as training, funding, and collaboration opportunities), lecturers' awareness and actions toward sustainability remain limited.^(17,18) Thus, while institutional commitment can drive change, its effectiveness depends on substantive implementation rather than symbolic gestures.

Institutional commitment can thus be understood as the attachment, loyalty, or formal promise of individuals to the core values, strategic goals, and operational rules of an organization or institution. This commitment not only plays a role in maintaining order, enhancing trust, and ensuring sustainable development within organizations and society, but also carries particular significance for faculty in higher

education. For lecturers, institutional commitment strengthens professional responsibility, fosters active engagement in teaching, research, and community service aligned with institutional directions, and motivates long-term dedication. It helps sustain consensus and collaboration within the faculty body, thereby improving the quality of teaching and scientific research. Moreover, institutional commitment shapes positive attitudes toward innovation and creativity in teaching, as well as in promoting sustainability values, thereby enhancing the reputation, brand, and competitiveness of higher education institutions in a globalized context.

Faculty training and capacity (TC)

Faculty training and faculty competence are two key factors in ensuring the quality of higher education. Faculty training is the process of professional development aimed at enhancing knowledge, skills, and professional attitudes, while faculty competence refers to the set of skills, knowledge, and personal qualities necessary to effectively fulfill teaching, research, and community service roles. Faculty training includes activities such as workshops, short courses, and professional development programs designed to help lecturers update their knowledge, pedagogical skills, technological expertise, research capacity, and management abilities. This training can focus on areas such as online teaching, competency-based curriculum development, or improving assessment and feedback skills. Effective training enhances confidence, fosters teaching innovation, and improves students' learning outcomes.^(19,20,21,22)

Faculty competence is a combination of personal and professional capacities

Disciplinary competence (subject-matter knowledge), pedagogical competence (teaching skills, course design, assessment), research competence (reviewing literature, conducting, and publishing research), personal development competence (lifelong learning, technological adaptability), and communication and collaboration competence.^(23,24,25,26,21) Modern faculty competency frameworks are often categorized into groups: personal competencies, technical/functional competencies, supporting competencies, and meta-competencies.^(25,26) While faculty training is a process of continuous professional development, faculty competence represents the consolidated set of skills, knowledge, and qualities required to effectively perform educational, research, and societal roles. Contemporary competency frameworks emphasize holistic development and adaptability to the rapidly changing educational landscape. Capacity is understood here as a broader concept that encompasses both current competencies (knowledge, skills, and attitudes) and the potential or readiness of faculty to apply and expand these competencies in teaching, research, and service. While “faculty development” refers primarily to the process of professional growth through training and institutional support, “capacity” represents the consolidated and actionable state of such growth. This usage is consistent with the literature on capacity building in higher education, where capacity is conceptualized as the integration of individual competence, professional development, and enabling conditions that allow faculty to fulfill their educational and societal roles effectively.

Facilities and green campus (FG)

Developing green infrastructure and promoting green campuses has become an important trend in higher education, aiming to foster sustainable development while enhancing the quality of life and learning for students. International and regional studies indicate that green campuses not only provide environmental benefits but also improve mental health, learning effectiveness, and the institutional image of universities. Common criteria include: the proportion of open space, green area, water permeability, facilities for people with disabilities, safety, health, and conservation programs⁽²⁷⁾. Evaluation systems such as the UI GreenMetric also help universities assess and enhance their green initiatives.^(27,28) Green infrastructure and campuses offer several benefits: Green spaces within campuses foster psychological restoration, improve quality of life, and enhance the mental health of both faculty and students^(29,30). Green campuses contribute to reducing carbon emissions, saving energy and water, and minimizing waste—even in resource-scarce areas^(31,28). While empirical evidence primarily links green infrastructure to student outcomes, emerging research suggests similar effects among faculty through environmental immersion and institutional signaling. Developing green campuses also raises awareness, knowledge, and actions related to sustainable development within academic communities of both faculty and students.⁽³²⁾

National and international collaboration (NI)

National and international collaboration is a key factor in advancing sustainable education, enabling resource sharing, knowledge exchange, and global capacity building. National collaboration refers to partnerships among universities, organizations, enterprises, and government agencies within a country to promote sustainable education through resource sharing, curriculum development, research, and pedagogical innovation. It plays a vital role in strengthening internal capacity, pooling resources, developing locally relevant programs, and

fostering joint implementation of sustainable education projects tailored to local needs.^(33,34) International collaboration involves linkages among educational institutions, international organizations, and stakeholders from different countries for academic exchange, joint research, collaborative curriculum development, conferences, and the establishment of global networks on sustainable education. Such collaboration enhances knowledge sharing, develops global competencies, fosters innovation, builds academic networks, supports the development of interdisciplinary programs, strengthens global skills, and encourages innovative teaching practices.^(35,36,37,38) Although collaboration offers many benefits, challenges such as power imbalances and resource disparities may affect outcomes

Teaching methods and course design (MD)

Education for Sustainable Development (ESD) requires innovative teaching methods and course design to develop systems thinking skills, the ability to address complex problems, and to foster practical action. Recent research highlights the importance of active, interdisciplinary, and collaborative learning in building effective curricula and pedagogical approaches for ESD. Prominent teaching methods include: Project-based learning, problem-based learning, experiential (outdoor) learning, and practice-based learning, which help students develop systems thinking, interdisciplinary collaboration, and environmental awareness.^(39,40,41) Design thinking, widely applied to address real-world challenges, fosters creativity, critical thinking, and innovation capacity in ESD.^(42,43,44,45) Collaboration across faculties, disciplines, and with external partners (such as businesses and communities) supports the development of a sustainability-oriented culture and enhances the ability to address complex problems.^(45,46,47,48)

Course and curriculum design for ESD should emphasize integrating entrepreneurship competencies into sustainability education, focusing on solving community problems and fostering innovative thinking. In addition, the use of competency-based assessment tools, frequent feedback, and real-world project-based learning improves learning outcomes and sustainability awareness.^(48,49,50) Moreover, combining extracurricular activities and community projects with formal curricula helps promote sustainable behavioral change.⁽⁵⁰⁾

Faculty awareness of sustainable development in higher education (AWA)

The faculty's understanding, attitude, and appreciation of sustainable higher education (ESD) are crucial for integrating sustainability into academic practices. This encompasses cognitive, affective, and behavioral awareness, which collectively shape how educators approach sustainability in their teaching and research. Faculty members generally possess a foundational understanding of sustainable development and the Sustainable Development Goals (SDGs).⁽⁵¹⁾ Most faculty members recognize the importance of sustainability in higher education and support the integration of sustainability into curricula and institutional practices.^(16,17,52,53)

Sustainable development in higher education (SDE)

Sustainable development in higher education is the process by which universities integrate the principles of sustainability into their strategies, curricula, research, management, and community engagement. Its goal is to generate positive economic, social, and environmental impacts while contributing to the achievement of the United Nations Sustainable Development Goals (SDGs).^(4,54,55,56,57,58,59)

The key components of sustainable higher education development include: Integrating Education for Sustainable Development (ESD) into curricula, equipping students with the knowledge, skills, and mindset to address sustainability challenges.^(4,58,60) Promoting interdisciplinary research, innovation, and community partnerships to tackle real-world environmental, social, and economic issues.^(56,57,60) Building a sustainability-oriented organizational culture, ranging from energy management and waste reduction to promoting gender equality and social justice.^(54,56,59,61) Ensuring stakeholder participation - including faculty, students, businesses, and communities—in the planning and implementation of sustainability strategies.^(55,60,62)

Research hypotheses and research model

Research hypotheses

Institutional commitment plays a crucial role in enhancing faculty awareness and fostering positive attitudes toward sustainable higher education. When universities demonstrate clear commitment and integrate sustainability principles into their strategies, policies, and organizational culture, faculty awareness and engagement in sustainability are significantly strengthened. Institutional commitment is the most important internal factor driving the implementation of sustainability initiatives within universities, while also motivating faculty to participate and recognize their role in sustainable education.^(14,16,63) Integrating sustainability into the mission, strategy, curricula, and institutional activities helps disseminate sustainable awareness and practices across the faculty.^(16,54,63) Leadership support, clear policies, and professional development programs for faculty are key factors in enhancing awareness and teaching capacity related to sustainability.^(16,53,64) Based on these

findings, the study proposes the following hypothesis:

- H1: Institutional commitment positively influences Faculty awareness of sustainable development in higher education.

Research indicates that faculty training and competency development have a significant and positive impact on faculty awareness, attitudes, and practices related to sustainable higher education. Training in sustainability helps faculty better understand the concepts, values, and competencies required to integrate sustainability into curricula, thereby enhancing their awareness and commitment to the topic.^(16,52,65,66) Competency frameworks emphasize the role of training in developing sustainable values, skills, and attitudes among faculty, enabling them to become both role models and change agents in higher education.^(52,65,66) Conversely, the absence of faculty training programs or misaligned competencies is a major barrier to effectively integrating sustainability into teaching.^(17,52,53) Well-trained faculty members in sustainability possess a more comprehensive understanding of its environmental, social, economic, and ethical dimensions, rather than focusing on a single aspect.^(17,52,66) Training also increases faculty confidence in applying active teaching methods—such as project-based learning and service learning—to foster sustainability competencies among students.^(52,67) Drawing on the above findings, this study advances the following hypothesis:

- H2: Faculty training and apacity positively influence Faculty awareness of sustainable development in higher education.

Several studies highlight that modern infrastructure and green campus initiatives contribute to enhancing faculty awareness and fostering positive attitudes toward sustainable higher education. Universities that implement green practices—such as energy management, waste reduction, and green spaces—create a sustainable learning environment, thereby strengthening faculty awareness and engagement in sustainability-related educational activities.^(68,66,69,70) Leadership commitment and sustainability policies serve as important mediating factors, encouraging faculty to better recognize their roles in sustainable education.^(71,72,73) Moreover, training and professional development programs on green and sustainability topics help faculty gain deeper insights into the environmental, social, and economic dimensions of sustainability, which they can then actively integrate into teaching.^(16,72) In light of these results, the following hypothesis is formulated:

- H3: Facilities and green campus positively influence Faculty awareness of sustainable development in higher education

Collaboration among faculty, departments, and universities—both domestically and internationally - positively influences awareness and practices related to sustainable higher education. Numerous studies demonstrate that international, interdisciplinary, and internal collaboration helps faculty gain deeper understanding, develop skills, and foster innovation in sustainability education. Participation in domestic and international programs, projects, or exchanges enables faculty to access new knowledge, modern teaching methods, and broaden their perspectives on sustainable development.^(16,37,35,74) Guided by the preceding discussion, the study posits the following hypothesis:

- H4: National and international collaboration positively influences Faculty awareness of sustainable development in higher education.

Innovative teaching practices contribute to increased faculty awareness of sustainability. However, their effectiveness is limited in the absence of professional training, resources, and institutional support.^(16,52,64,53,75) The integration of sustainability content into curricula and teaching guidelines is a key factor in transforming faculty awareness and practice.^(16,52,76) From this theoretical and empirical background, the following hypothesis is derived:

- H5: Teaching methods and course design positively influence Faculty awareness of sustainable development in higher education

Studies demonstrate that faculty awareness, attitudes, and competencies are key factors in advancing sustainable higher education. Faculty members with a positive awareness of sustainability are more likely to support the integration of sustainability content into curricula, propose appropriate pedagogical approaches, and actively engage in sustainability-related activities.^(17,66,77,78) However, the level of understanding and readiness to act varies across disciplines, types of institutions, and national contexts.^(17,77) Accordingly, the study puts forward the following hypothesis:

- H6: Faculty awareness of sustainable development in higher education positively influences Sustainable development in higher education.

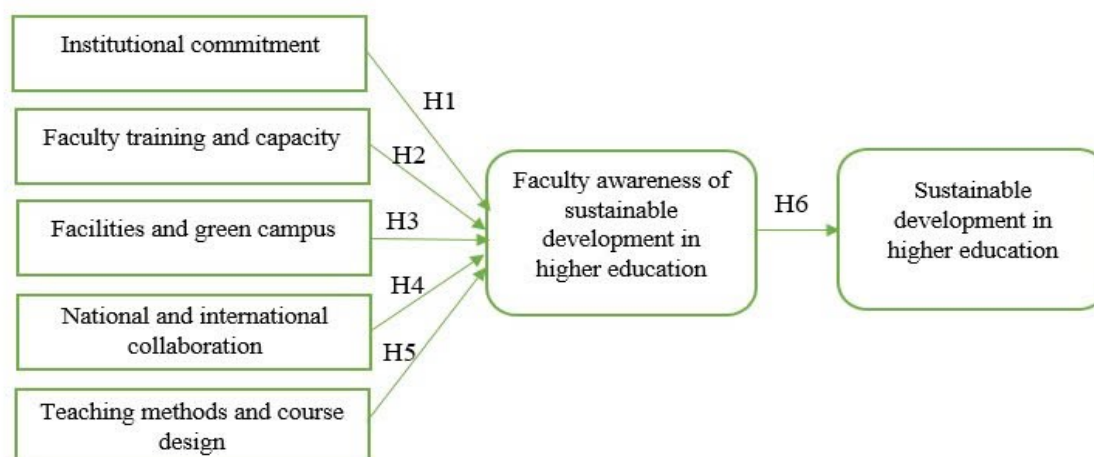


Figure 1. Research model

METHOD

The questionnaire consists of 26 observed variables categorized into 7 proposed factor groups. All items were adapted from established measurement scales in prior studies and refined to fit the context of sustainable development in higher education. Specifically, the scales for Institutional Commitment (IC) were adapted from ^(7,8,9,10). Faculty training and capacity (TC) items were drawn from ^(19,20,22,21,23,24,25,26). Facilities and green campus (FG) items were based on ^(27,28,31,32). National and international collaboration (NI) items followed ^(33,34,35,36,37,38). Teaching methods and course design (MD) items were adapted from ^(40,42,43). Faculty Awareness (AWA) items were drawn from ^(16,17,52,53,51). Finally, Sustainable development in higher education (SDE) items were adapted from ^(54,55,56,57,58).

To ensure linguistic accuracy, the questionnaire was translated into Vietnamese and then back-translated into English. A pilot test was conducted with 30 lecturers to assess clarity, cultural appropriateness, and preliminary reliability of the scales. Minor revisions in wording were made based on participants' feedback. Cronbach's alpha values from the pilot study exceeded the recommended threshold of 0,70 (Nunnally & Bernstein, 1994) for all constructs, indicating satisfactory internal consistency. The final instrument was administered using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Data collection was conducted through Google Forms, both directly from lecturers and indirectly via academic social networks. The main sample included 339 university lecturers.

The study applies a convenience sampling method due to the difficulty of fully controlling the survey population in the field of education. To mitigate potential sampling bias, the questionnaire was widely distributed through professional academic networks, social media platforms, and institutional mailing lists, aiming to reach lecturers across different disciplines, university types (public and private), and geographic regions in Vietnam. This approach enhanced diversity in the sample and reduced the risk of over-representing any particular group of faculty members. Participation was entirely voluntary, anonymous, and based on informed consent. Respondents were informed of the study's objectives, confidentiality procedures, and their right to withdraw at any time without consequence. Data were collected and stored in compliance with research ethics and data protection standards.

The study employs the Partial Least Squares Structural Equation Modeling (PLS-SEM). The analysis was conducted using SmartPLS 4 software in two steps: (i) assessment of the measurement model and (ii) assessment of the structural model. In the first step, the reliability and validity of the measurement scales were tested through outer loading, Cronbach's Alpha, Composite Reliability (CR), rho_A, and AVE, along with discriminant validity assessment using the Fornell-Larcker criterion and HTMT; multicollinearity was also checked using the VIF index. In the second step, the structural model was evaluated based on VIF and the coefficient of determination (R^2). The parameters were estimated using the PLS algorithm, and statistical significance was tested via bootstrapping with a 95 % confidence interval.

DISCUSSION

Measurement model

After data preprocessing, the research team used SmartPLS software to validate the measurement model based on four criteria: quality of observed variables, reliability, convergent validity, and discriminant validity of the measurement scales.

First, the observed variables were tested through outer loading. According to F. Hair Jr. et al. (2014), an outer loading $\geq 0,708$ is considered acceptable, ensuring the reliability of the observed variables. Conversely,

variables with an outer loading $< 0,70$ were eliminated to improve the reliability of the scales. In addition, the reliability of the measurement model was assessed using Composite Reliability (CR) and Cronbach's Alpha (CA). Although both indicators are widely applied, many studies suggest that CR is a more accurate measure of construct reliability, while Cronbach's Alpha tends to underestimate the actual reliability.⁽⁷⁹⁾ For exploratory research, a CR value of 0,60 or above is generally considered acceptable, as it indicates an adequate level of internal consistency for preliminary model testing.⁽⁸⁰⁾ Therefore, the threshold of $CR \geq 0,60$ is adopted in this study, given its exploratory nature. In contrast, for confirmatory studies, several scholars such as^(79,81,80) recommend a CR threshold of $\geq 0,70$, which is also considered a standard criterion for assessing scale reliability. The initial analysis revealed that two observed variables, SDE2 and SDE3, did not meet the required thresholds for outer loading and CR; hence, they were excluded from the model.

The third criterion for assessing the measurement model is convergent validity. A measurement scale is considered to have adequate convergent validity when the Average Variance Extracted (AVE) $\geq 0,50$, meaning that the latent variable explains at least 50 % of the variance of the observed variables.

The results after reassessing the quality of the observed variables, reliability, and convergent validity of the scales are presented in table 1 and table 2, as follows:

	AWA	FG	IC	MD	NI	SDE	TC
AWA1	0,862						
AWA2	0,892						
AWA3	0,880						
FG1		0,751					
FG2		0,852					
FG3		0,858					
FG4		0,767					
IC2			0,823				
IC3			0,925				
IC4			0,898				
MD1				0,832			
MD2				0,827			
MD3				0,817			
MD4				0,754			
NI1					0,821		
NI2					0,883		
NI3					0,866		
NI4					0,885		
SDE1						1,000	
TC1							0,880
TC2							0,904
TC3							0,850
TC4							0,893
IC1			0,735				

	Cronbach's Alpha	Composite Reliability	AVE
AWA	0,852	0,910	0,771
FG	0,824	0,883	0,654
IC	0,898	0,911	0,720
MD	0,824	0,882	0,653
NI	0,887	0,922	0,747
SDE	1,000	1,000	1,000
TC	0,905	0,933	0,778

	AWA	FG	IC	MD	NI	SDE	TC
AWA	0,878						
FG	0,248	0,809					
IC	0,124	0,055	0,849				
MD	0,193	0,292	-0,028	0,808			
NI	0,311	0,234	0,051	0,241	0,864		
SDE	0,360	0,388	0,124	0,326	0,375	1,000	
TC	0,244	0,186	-0,028	0,271	0,169	0,319	0,882

Furthermore, to ensure discriminant validity, the study applied two evaluation criteria. First, the square root of the AVE, as proposed by ^(81,82). Discriminant validity is confirmed when the square root of the AVE for each latent variable is greater than all correlations between that latent variable and the others.

Second, the Heterotrait-Monotrait (HTMT) ratio, proposed by Henseler et al. with an acceptable threshold of HTMT < 0,85, and in some cases, HTMT < 0,90 may be applied. The detailed results are presented in table 3 and table 4.

	AWA	FG	IC	MD	NI	SDE	TC
AWA							
FG	0,290						
IC	0,103	0,088					
MD	0,224	0,360	0,074				
NI	0,354	0,274	0,074	0,280			
SDE	0,389	0,426	0,111	0,362	0,395		
TC	0,276	0,215	0,089	0,314	0,184	0,335	

Structural model

After conducting the analysis, the authors obtained the results presented in figure 2.

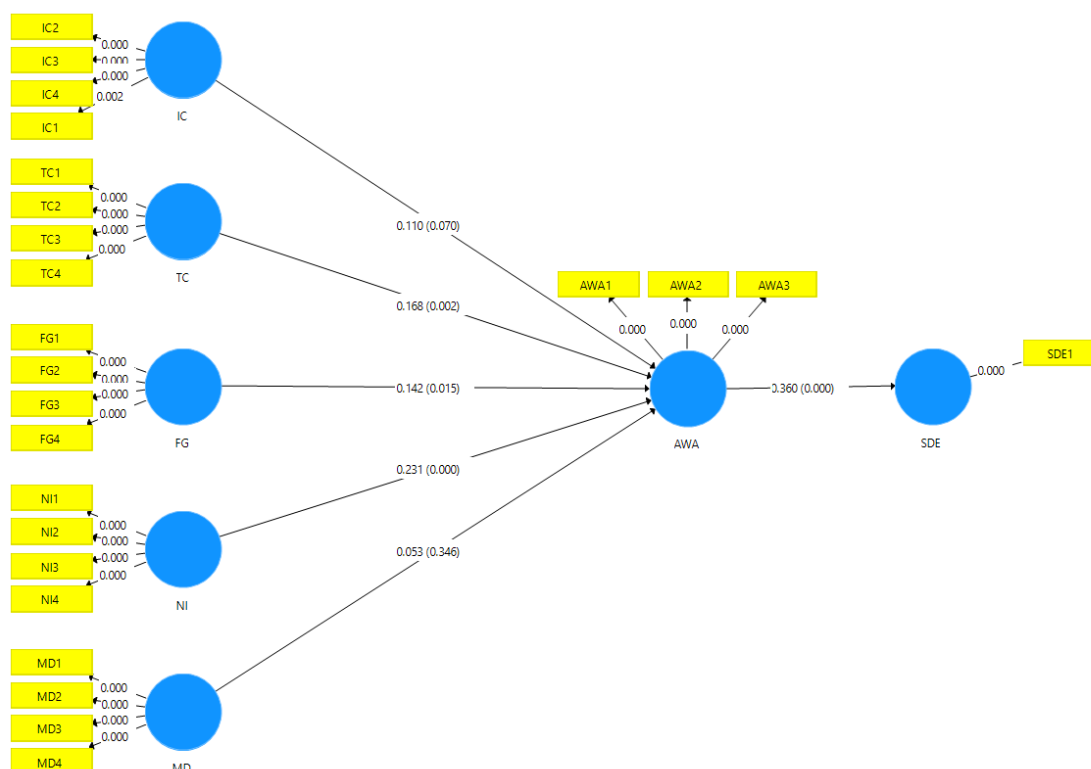


Figure 2. Structural model results with path coefficients and p-values

p-value < 0,05 indicates statistical significance. However, in some cases, particularly exploratory studies, a threshold of $p < 0,10$ may also be acceptable. The results shown in Figure 1 indicate that 5 out of the 6 p-values are below 0,10, of which 4 relationships reach the level of $p < 0,05$, including:

Faculty training and capacity (TC) positively influence Faculty awareness of sustainable development in higher education (AWA)

Facilities and green campus (FG) positively influence Faculty awareness of sustainable development in higher education (AWA)

National and international collaboration (NI) positively influence Faculty awareness of sustainable development in higher education (AWA)

Faculty awareness of sustainable development in higher education (AWA) positively influence Sustainable development in higher education (SDE)

Institutional commitment (IC) positively influence Faculty awareness of sustainable development in higher education (AWA) was assessed as weak, since the standardized coefficient reached only 0,070, falling within the range (0,05; 0,1). In addition, to test for multicollinearity, the authors used the Variance Inflation Factor (VIF) as a measure. Specifically, a $VIF \geq 5$ indicates a very high likelihood of multicollinearity, while a VIF in the range [3; 5] suggests a possible occurrence of multicollinearity, and if $VIF < 3$, there is no evidence of multicollinearity. Therefore, any independent variable with $VIF > 5$ should be removed or the model should be adjusted. In this study, all independent variables had VIF values < 3, as shown in table 5, so none were eliminated.

	AWA	FG	IC	MD	NI	SDE	TC
AWA						1,000	
FG	1,143						
IC	1,009						
MD	1,188						
NI	1,108						
SDE							
TC	1,105						

In addition, considering the adjusted R^2 , the results are as follows:

	R^2	Adjusted R^2
AWA	0,172	0,160
SDE	0,129	0,127

Faculty awareness of sustainable development in higher education (AWA) has an adjusted $R^2 = 0,160$, meaning that the independent variables explain 16 % of the variance of AWA. Sustainable Development in Higher Education (SDE) has an adjusted $R^2 = 0,127$, meaning that the independent variable AWA explains 12,7 % of the variance of SDE.

CONCLUSIONS

The findings reveal that faculty awareness of sustainable development in higher education is significantly influenced by faculty training and capacity, facilities and green campus initiatives, as well as national and international collaboration. In contrast, suggesting that policy declarations alone are insufficient without accompanying resources and incentives. Moreover, faculty awareness is confirmed as a crucial mediating factor that fosters sustainable development within universities. Based on these insights, several implications can be drawn:

Universities should invest more systematically in faculty training and capacity-building programs related to Education for Sustainable Development (ESD), including workshops, professional development courses, and international learning opportunities.

Green campus development should be prioritized not only as an environmental strategy but also as a pedagogical tool to strengthen faculty and student engagement with sustainability.

Cross-level collaboration—within departments, across domestic institutions, and internationally—should be expanded to facilitate resource sharing, methodological innovation, and knowledge exchange.

Institutional commitment needs to be translated into concrete strategies, long-term action plans, and incentive mechanisms to effectively integrate sustainability into teaching, research, and management practices.

LIMITATIONS

This study is subject to several limitations. First, the use of convenience sampling may limit the representativeness of the findings and restrict their generalizability across the higher education sector. Second, the short research timeframe and the focus on selected institutions provide only a snapshot rather than a longitudinal view of faculty awareness. Third, the explanatory power of the proposed PLS-SEM model remains moderate, indicating that additional variables may account for variations in faculty awareness and sustainable development in higher education.

Future research could address these limitations in several ways:

Expanding the dataset to cover a broader range of universities across regions and institutional types to enhance generalizability.

Incorporating qualitative approaches such as in-depth interviews and focus groups to uncover deeper insights into faculty motivations, challenges, and institutional barriers.

Extending the research model by integrating additional factors such as organizational culture, leadership roles, and national policy frameworks that may affect sustainable higher education.

Conducting longitudinal studies to track the evolution of faculty awareness and practices over time, thereby capturing dynamic changes and long-term impacts.

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